# MDA-QS-003
# PMP Mission Assurance Plan
## (Defense Standardization Program Office (DMAP)
## Part Standardization & Management Committee (PSMC)

24 October 2007

Missile Defense Agency
PMP Board Chairman

# PMAP Approved by Agency Director

**TMENT OF DEFENSE**
**E DEFENSE AGENCY**
**EFENSE PENTAGON**
**NGTON, DC 20301-7100**

QS

12 December 2006

MEMORANDUM FOR PROGRAM CONTROL BOARD

SUBJECT: Parts, Materials, and Processes Mission Assurance Plan

The Missile Defense Agency (MDA) Parts, Materials, and Processes Mission Assurance Plan (PMAP) applies to all mission and safety critical systems. New contracts are required to incorporate these requirements; existing systems shall present any impacts to their programs **as** a result of implementing the PMAP to the Program Change Board no later than 1 March 2007.

The MDA PMAP supports the operations and sustainment of capabilities to the warfighter by eliminating variability in the derating, screening and qualification of parts and materials critical to the reliability of all MDA systems. Through the establishment of an Agency PMAP Board structure and Center of Excellence, MDA ensures consistent application of requirements across all programs while advancing the reliability of emerging parts and materials through Industry participation.

Based upon the MDA Executive Management Council's review of the MDA PMAP, I approve the subject document, MDA-QS-0003-PMAP, dated 20 October 2006 **as** the MDA requirements document for mission critical parts, materials, and processes.

**SIGNED**

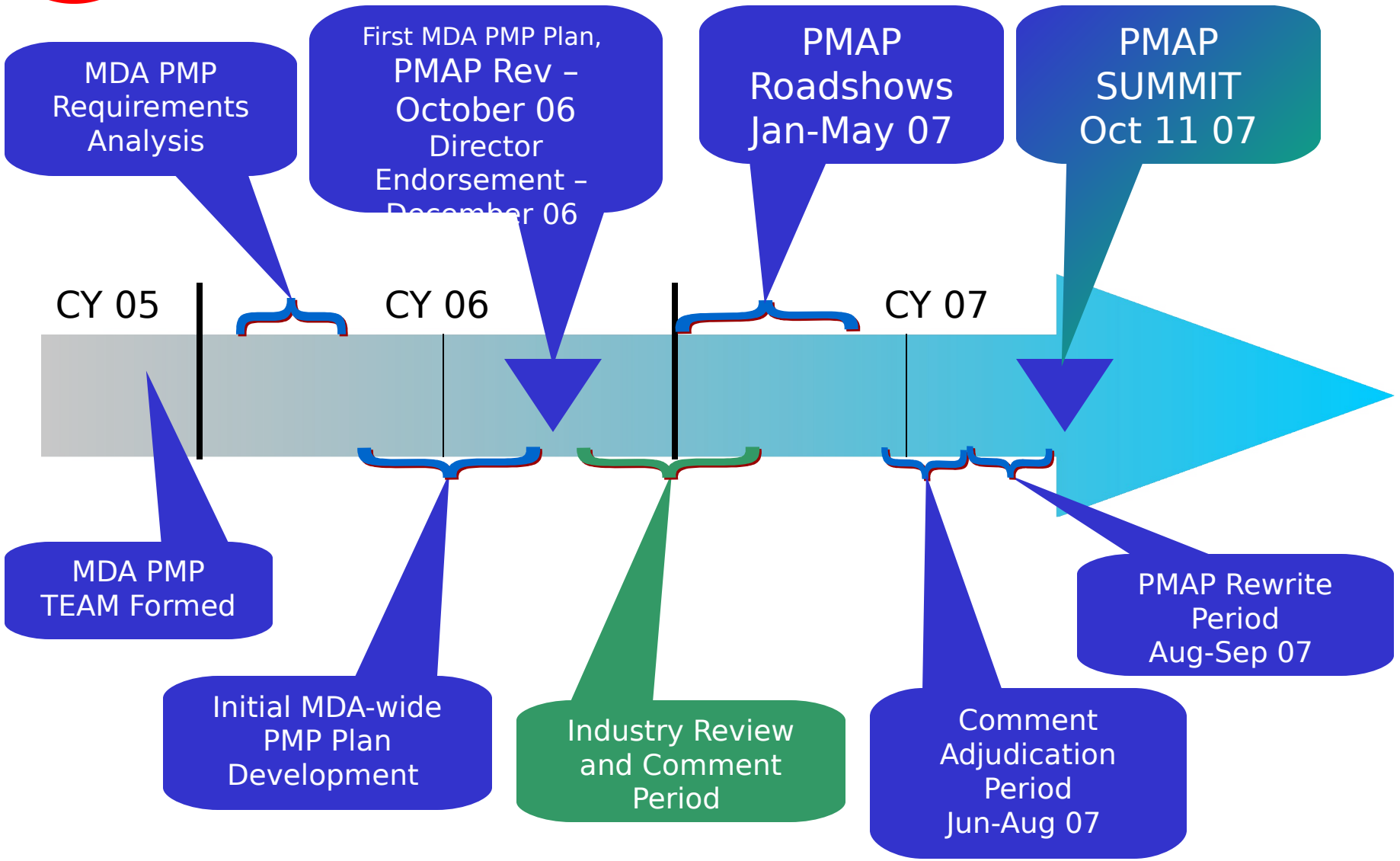
Henry A. Obering III
Lieutenant General, USAF
Director

# Why Develop An Agency PMP Plan?

- **Parts, Materials, and Processes (PMP) form the basic building blocks of a system**
  - **Inherent reliability of hardware is dependent upon reliability of PMP**
- **QS audits and NSWC Crane analyses determined lack of robustness in MDA Element's approach to PMP management**
- **Higher than expected percentage of MDA audit findings were PMP related**
- **BMDS has wide variety of application environments:**
  - **Space, Interceptors, Airborne, Sea- & Land-based Rugged, Ground**
- **PMAP further defines the PMP requirements of MAP section 3.6**

**DA Programs Require PMAP Application Guidan**

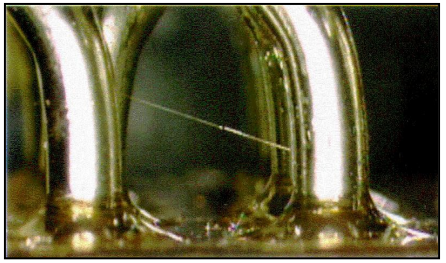
# A Brief PMAP History


MDA PMP Requirements Analysis
First MDA PMP Plan, PMAP Rev – October 06 Director Endorsement – December 06
PMAP Roadshows Jan-May 07
PMAP SUMMIT Oct 11 07
CY 05
CY 06
CY 07
MDA PMP TEAM Formed
Initial MDA-wide PMP Plan Development
Industry Review and Comment Period
Comment Adjudication Period Jun-Aug 07
PMAP Rewrite Period Aug-Sep 07

# Why the PMAP is Necessary…
## *Industry State of Affairs*

- **Overseas Plants**
  - Limited processes and material change insight
  - Military parts built on commercial manufacturing lines
  - Foreign countries can reverse engineer military technology

- **Unauthorized Distributors**
  - No established relationship with part vendors, poor quality, no recourse – traceability issues
  - Inconsistency in vendor lot to lot parameters
  - Counterfeit parts



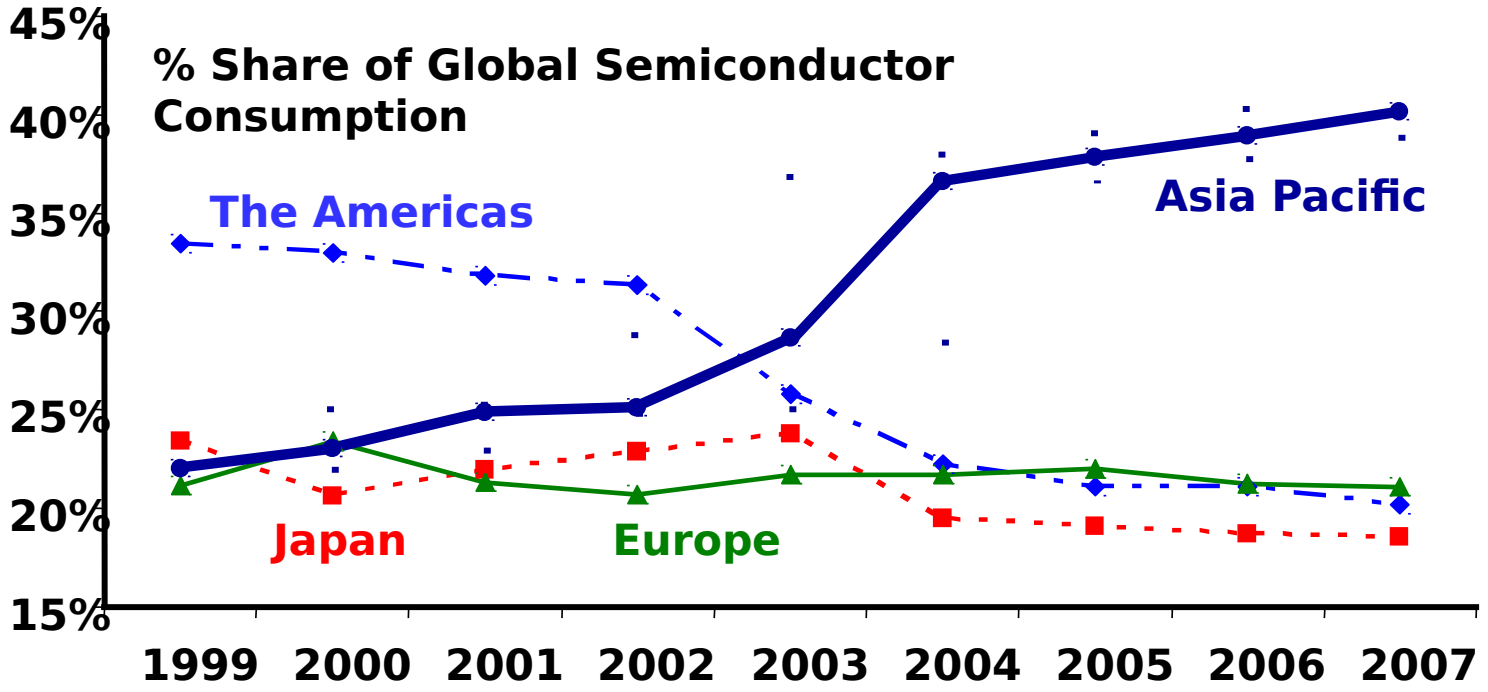
- **RoHS Lead-free Initiative**
  - Pandemic for Hi-Rel systems
  - No accepted method for tin-whisker mitigation

- **Obsolete Parts**
  - Government - military and space application
    EEE parts represent decreasing market share

**Commercial Driven Industry = Greater Controls Required**

# Worldwide Semiconductor Market

- **China/Taiwan growth has created the largest semiconductor market in the world**




*Source: WSTS/SIA*

# Why Not Use an Existing PMP Standard?

- **MIL-HDBK-965, Acquisition Practices for Parts Management was cancelled without replacement, 4 October 2000**
- **MIL-HDBK-512, Parts Management Handbook focuses on parts standardization and does not address Parts Review Board or technical requirements**
- **ANSI/AIAA – R-100A-2001, generic specification for a Parts Management Program (checklists)**
- **November 2006: Aerospace Corporation released TOR-2006(8583)-5235, PMP Control Program for Space and Launch Vehicles to replace MIL-STD-1546. This document utilizes a Parts Review Board but focuses on Space and Launch Vehicles only**

**No PMP Industry Standard for All MDA Applicati**

# PMAP Executive Summary

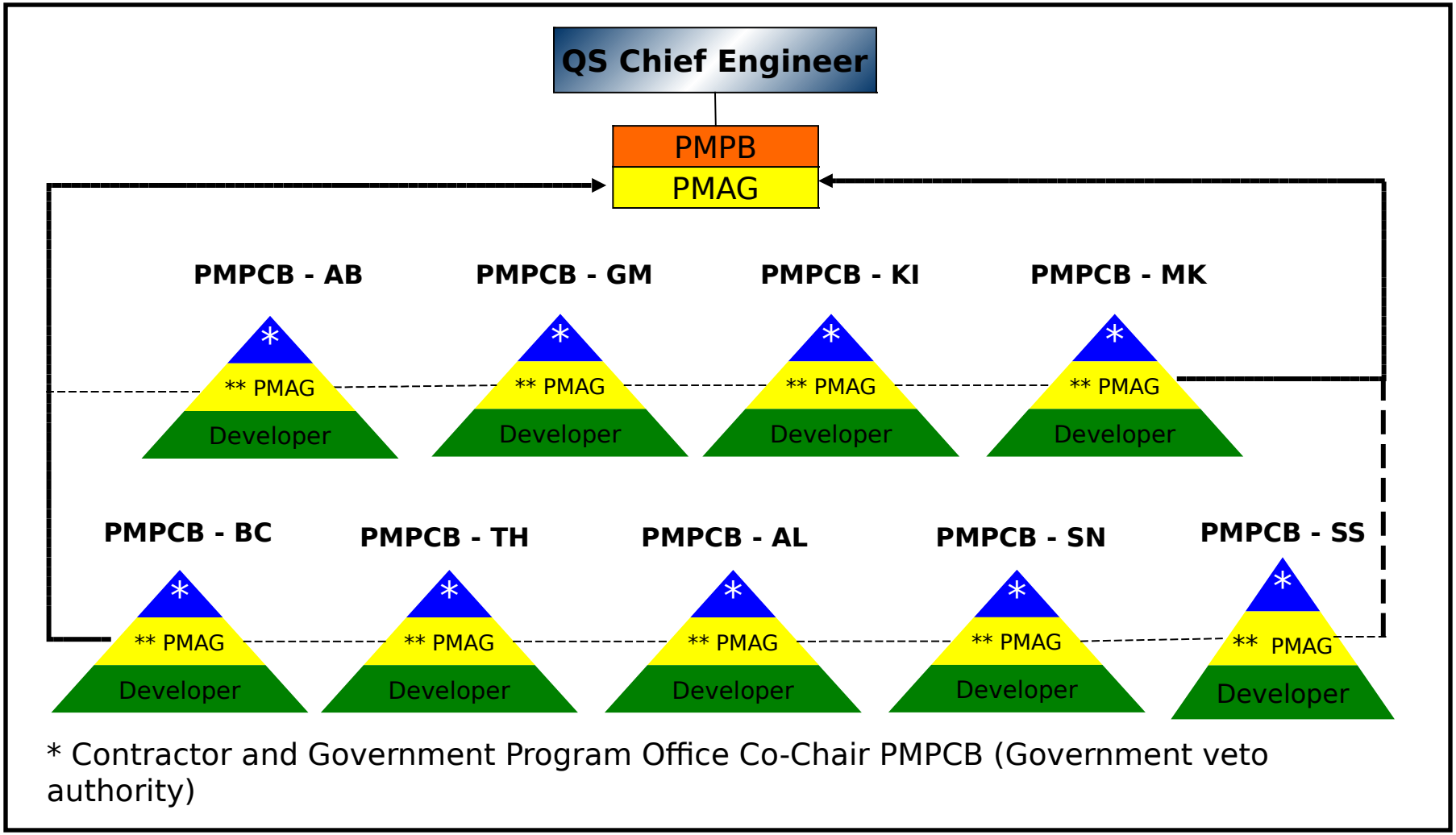
- **Purpose: PMAP provides PMP requirements and management structure to offset emerging part and material issues facing the Agency (e.g., counterfeit parts, service life issues, tin whisker/lead free, unreliable suppliers)**
- **Scope: Applies to new or modified safety and mission critical systems throughout the complete product life cycle: design, development, operation, and sustainment**
- **Requirements: Tailored by hardware categories, e.g. space, sea-based, ground-based**
- **Effectivity: Dependent upon each Program's place in the acquisition cycle and/or opportunity for redesign**

# PMAP Road Shows

- **To assist contractors and program offices in preparing PMAP impacts, MDA/QS PMP conducted a series of Road Show meetings at MDA prime contractor facilities February through July 2007 to:**
  - **Provide overall summary of PMAP requirements and MDA expectations for implementation**
  - **Solicit feedback and suggestions for more cost effective way to implement PMAP**
- **Road show attendance averaged 30-40 persons including PMP experts, Vice Presidents, Program Managers, Mission Success Directors, etc.**
  - **Active participation and feedback sessions on detailed topics**
  - **Collected over 200 suggested changes to PMAP (some redundant)**
  - **Contractors generally favorable with PMAP High Reliability approach to PMP management**

**Industry Partnered approach taken on PMAP results in maximum effectiveness within budg**

# Proposed PMP Board Construct




* Contractor and Government Program Office Co-Chair PMPCB (Government veto authority)

**MDA Part and Material Advisory Group (PMAG) shared across all programs to ensure uniformity

# PMP Board Management Structure

- **All parts, materials, and key processes selected for use require approval from a PMP Control Board (PMPCB)**
- **MDA Program Offices run their own PMPCB**
  - **PMPCB will review attribute data for selected PMP**
- **Government Program Office and Prime Contractor will co-chair the PMPCB, (Government has veto authority)**
- **Agency PMP Board (PMPB) interfaces with element PMPCBs to:**
  - **Ensure consistent application of PMP management across programs**
  - **Share information across programs**
  - **Coordinate QS Part and Material Advisory Group (PMAG) assistance to all programs**
  - **Disposition Severity Category 1 Prohibited PMP**

# Part and Material Advisory Group (PMAG) Proposed FY08

## MDA/QS PMAG

- **Utilize ARMY AMRDEC and NAVY NSWC Crane**
- **In-depth technical expertise to assist programs, share PMP test facilities/resources, and interact with industry on behalf of MDA**
- **Provides commodity expertise (e.g. Microcircuits, Passive Devices, Materials, etc.)**
- **Staffed by QS and available to all MDA programs**

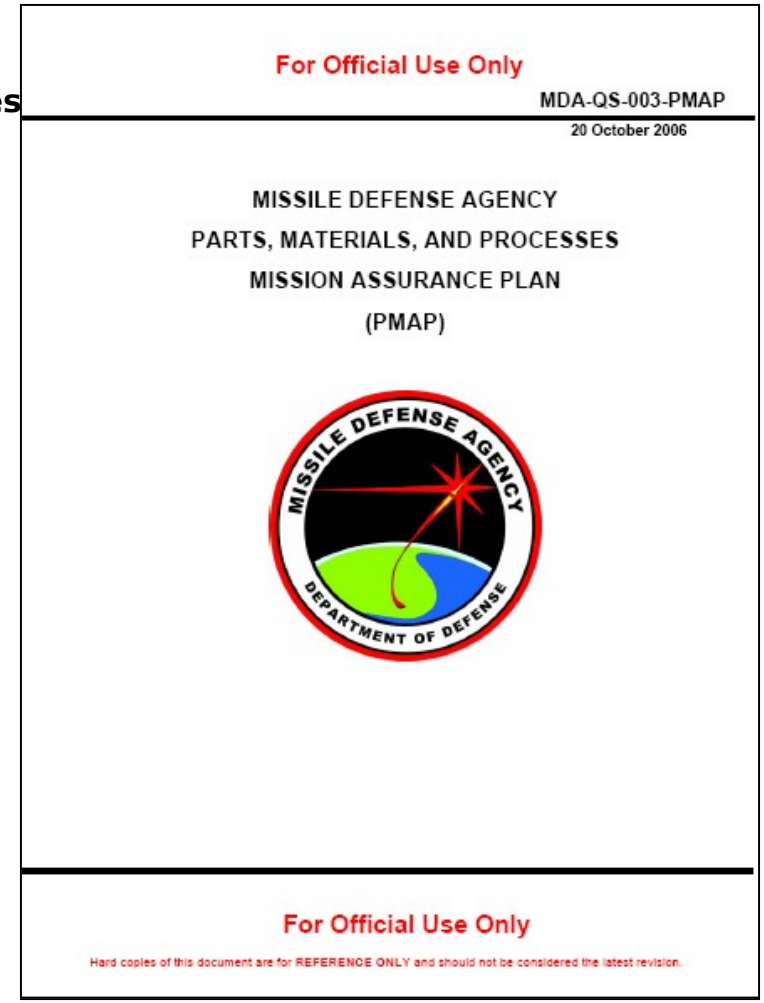
AMRDEC
STRENGTH THROUGH TECHNOLOGY

NAVSEA
WARFARE CENTERS
CRANE

## Program Office PMPCB

# PMAP Contents

- **Applicable Documents (References)**
  Government and Commercial
- **PMP Management Structure, Roles, and Responsibilities**
  PMP Board, PMP Control Board, COE
- **PMP Requirement examples**
  EEE Parts
  Materials
  Corrosion Prevention
  Prohibited Parts and Materials
  PMP Quality Requirements
  PMP Procurement Management
  Radiation Hardness Assurance
  Government Furnished Equipment and Material
  PMP Qualification
  COTS Management
  Non-Conforming
  Failure Analysis
  ESD
  Environmental Controls
  Handling
  Preservation, Packaging, and Storage
- **Appendices**
  Derating
  PEM
  COTS
  Radiation Hardness Assurance
  Prohibited Items Requiring Special Consideration
  PMAP Data Items
  Corrosion
  PMAP Compliance Matrix


For Official Use Only

MDA-QS-003-PMAP

20 October 2006

MISSILE DEFENSE AGENCY

PARTS, MATERIALS, AND PROCESSES

MISSION ASSURANCE PLAN

(PMAP)

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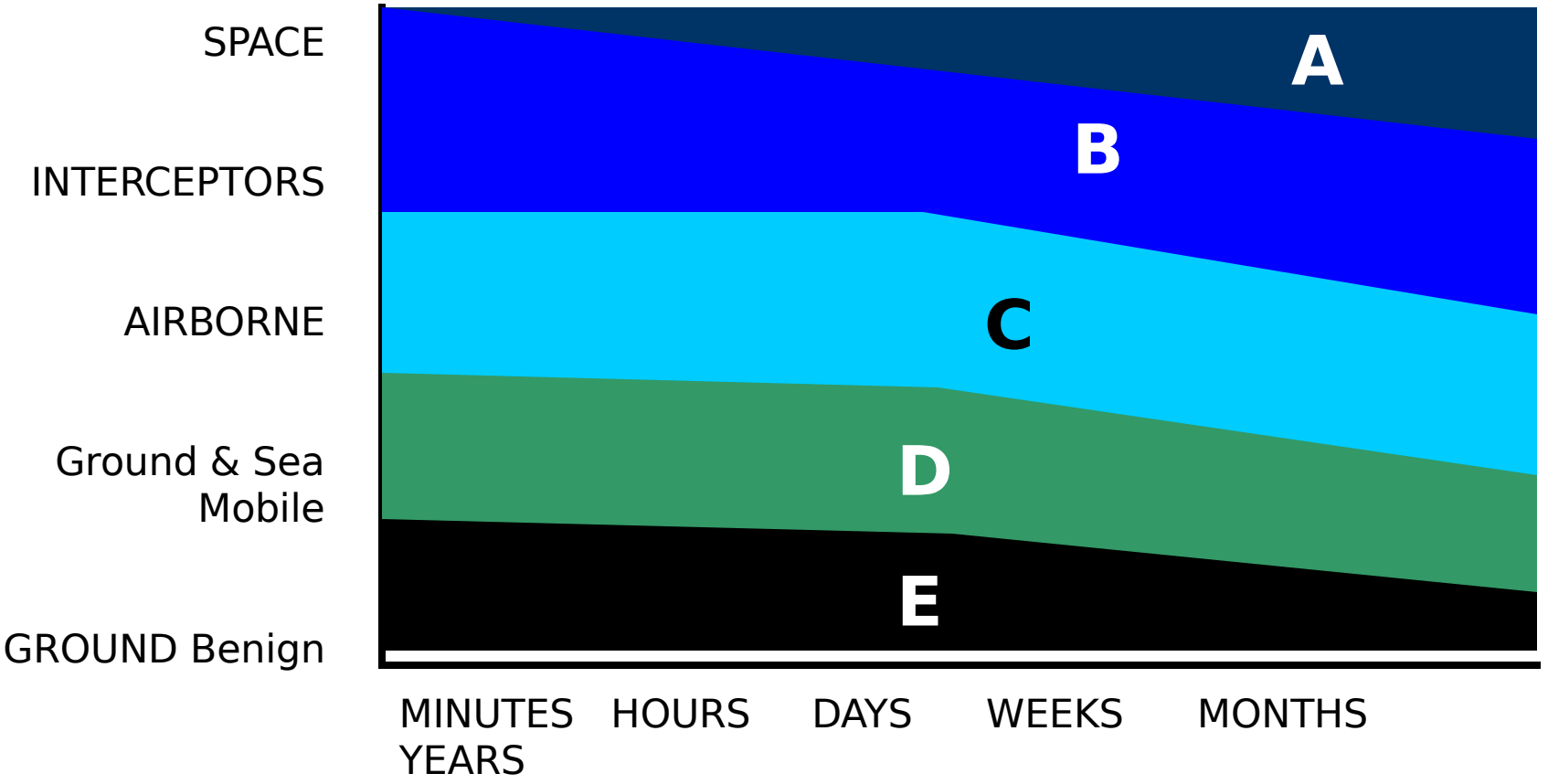
Hard copies of this document are for REFERENCE ONLY and should not be considered the latest revision.

# Program Categories & Definitions

- **5 Program Environmental Categories A (Long-term Space) through E (Ground Sheltered)**



# Parts Screened for Application

**3.2 Hardware Categories and Definitions**

**Category A:** Continuous use systems, under space environment conditions, non-repairable, such as satellite systems that encounter severe environment conditions from launch, flight trajectory and orbit. System flow-down radiation hardness requirements (low dose rate, high total dose) must be satisfied. Category A mission application includes STSS and DSP.

**Category B:** Impulse (Single shot) systems encountering extreme conditions related to launch (air, ground and sea), flight trajectory, vehicle boost into exo-atmosphere, and vehicle reentry. Category B hardware can be subjected to periods of long term storage. Once deployed, equipment is non-repairable. System flow-down radiation hardness requirements (possible high dose rate, low total dose) must be satisfied. Category B mission application includes SM3, THAAD, KI, EKV, MKV, GBI, etc.

**Category C:** Extended use aircraft systems, intermittent use sensors, non-repairable in field, and occupied by an air crew. Equipment exposed to turbulence and air temperature fluctuations. Extreme pressure, shock, and vibration are minimal. Category C mission application includes long mission aircraft such as Airborne Laser.

**Category D:** Ground and Sea-based systems (mobile/stationary), repairable, exposed to one or more of the following: temperature and humidity fluctuations, vibration, shock, and Electromagnetic Environmental Effects. Category D mission application includes ground and sea-based missile support equipment, launchers, ground sensors, sea-based sensors, command and control, combat systems, and field test equipment.

**Category E:** Ground systems (stationary), repairable, in temperature and humidity controlled environments readily accessible to maintenance. Category E mission application includes C2BMC, facility test equipment, and computer complexes. Hardware in this category is typically used in 24/7 systems.

**PMAP defines 5 Program categories**

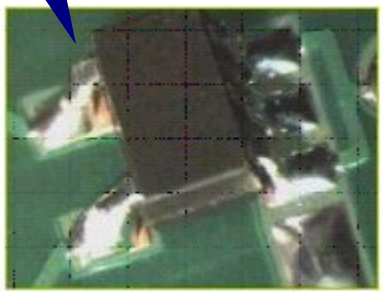
- **Specific quality levels required for categories A –E**
- **All EEE parts shall be screened to ensure they meet or exceed application requirements**

**Table 2. Minimum Quality/Failure Rate Level for EEE Parts**

| Quality Level (Class) or Failure Rate Levels (FRL) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Part | Cat A | Cat B | Cat C | Cat D | Cat E | Reference Specification | |
| Microcircuits | V | Q 4/ | Q or N | Q or N | Commercial | MIL-PRF-38535 1/ | |
| Hybrid Microcircuits | K | H | H | H | Commercial | MIL-PRF-38534 | |
| Discrete Semiconductors | JANS | JANTXV, JANTX | JANTX | JANTX | Commercial | MIL-PRF-19500 1/ | |
| Capacitors, Established Reliability (ER) | S | R | R | P | Commercial | **Ceramic** - MIL-PRF-20 - MIL-PRF-123 - MIL-PRF-39014 - MIL-PRF-55681 - MIL-PRF-49470 | **Tantalum** - MIL-PRF-39003 2/ - MIL-PRF-39006 - MIL-PRF-55365 2/ |
| | | | | | | **Glass** - MIL-PRF-23269 | **Plastic** - MIL-PRF-83421 - MIL-PRF-87217 |
| Capacitor (non-ER) | Mil | Mil | Mil | Mil | Commercial | **High Voltage** - MIL-PRF-49467 | |
| Resistors (ER) | T | R | R | P | Commercial | **Film** - MIL-PRF-39017 - MIL-PRF-55182 - MIL-PRF-55342 | **Wirewound** - MIL-PRF-39005 - MIL-PRF-39007 - MIL-PRF-39015 |
| | | | | | | **Power** - MIL-PRF-39009 | **Network** - MIL-PRF-83401 |
| Resistors (non-ER) | Mil | Mil | Mil | Mil | Commercial | **High Voltage:** MIL-PRF-49462 | |
| Coils, Molded (ER) | T | R | R | P | Commercial | MIL-PRF-39010 | |
| Coils, Molded (non-ER) | Mil | Mil | Mil | Mil | Commercial | MIL-PRF-83446 | |
| Magnetics | S 3/ | T | T | M | Commercial | MIL-PRF-27, MIL-PRF-21038, MIL-STD-981 | |
| Relays (ER) | R | R | R | P | Commercial | MIL-PRF-39016 | |
| Crystals | Mil | Mil | Mil | Mil | Commercial | MIL-PRF-3098 | |
| Crystal Oscillator | Class S | Class B | Class B | Class B | Commercial | MIL-PRF-55310 | |
| Connectors | Mil | Mil | Mil | Mil | Commercial | MIL-DTL-38999, MIL-DTL-24308, MIL-DTL-83513, MIL-DTL-55302, MIL-PRF-39012 | |
| Filters | S | B | B | B | Commercial | MIL-PRF-28861, MIL-PRF-15733 | |
| Fuses | Mil | Mil | Mil | Mil | Commercial | MIL-PRF-23419 | |
| Switches | Mil | Mil | Mil | Mil | Commercial | MIL-PRF-8805, MIL-PRF-24236 | |
| Thermistors | Mil | Mil | Mil | Mil | Commercial | MIL-PRF-23648 | |
| Wire and Cable | Mil | Mil | Mil | Mil | Commercial | MIL-W-22759, MIL-W-81044, MIL-C-17 | |

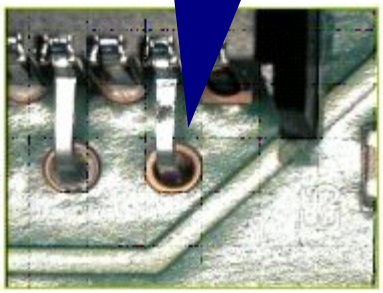
# Lead Free Solder Issues

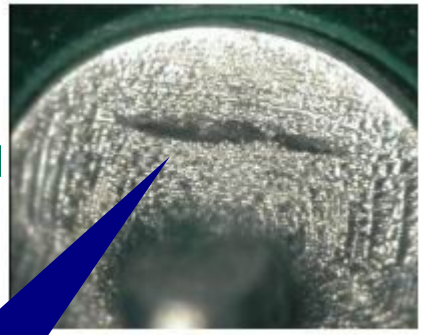
Poor wetting on SOIC



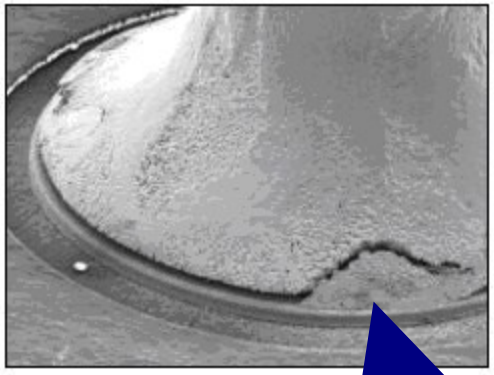
"Icicling" caused by low Pb-free solder temp

Poor hole fill from inadequate solder flow





Pb-free solder "tearing"



Fillet lifting and cracking (brittleness)

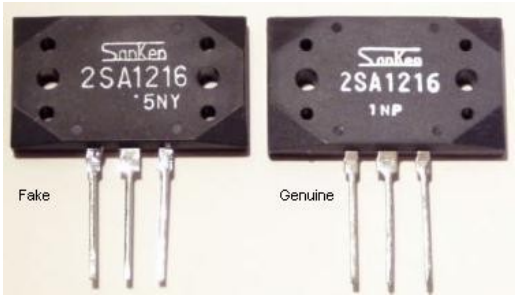
# PMAP Combats Lead Free Risks

- **PMAP 3.2.8 Lead-Free Solder Alloys and Surface Finishes:**
  - **Categories A, B, C – lead-free currently not permitted until risks fully understood in industry (includes pure tin, tin-silver, tin-bismuth, tin-copper and tin-indium)**
  - **Categories D, E – lead-free permitted if no other option – must understand risks to program through PMPCB**
  - **Nickel-palladium-gold (NiPdAu) lead finish and tin plated copper wire is allowed (no known instances of whisker growth) for all hardware categories**
  - **Contractors shall develop an approach to minimize inadvertent use of lead-free parts, including specific inspection methods for detecting lead-free parts and/or flow down of requirements to lower level suppliers to ensure compliant parts**

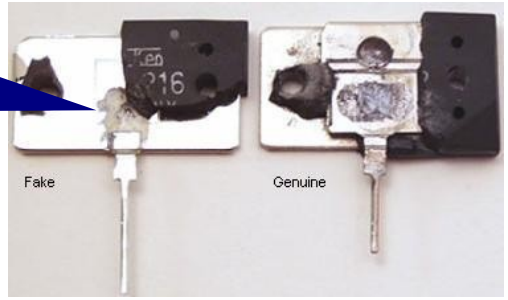
# Counterfeit Components (Examples)

Counterfeit capacitors with substandard electrolyte

Counterfeit Genuine




Fake vs genuine. Note the difference in die size after de-encapsulation




Counterfeit Genuine

Note the difference in component marking. This one, from PMC-Sierra, shows faked company symbol, including scratches where original marking was removed

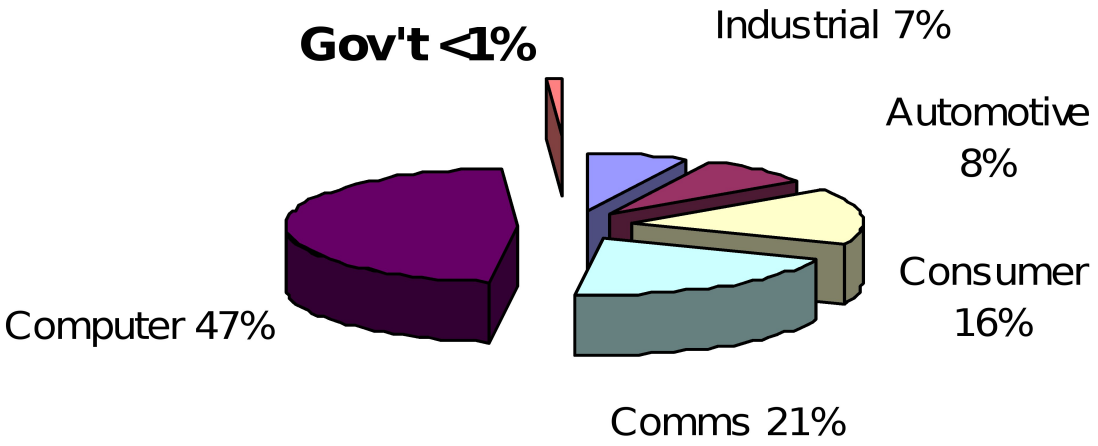
# PMAP Combats Counterfeit Parts

- **PMAP 3.6.7 depicts specific receiving inspection requirements to assist in identifying counterfeit parts**
- **PMAP 3.6.8 includes specific instructions on preventing, containing, and notifying user community about counterfeit parts**
- **PMAP 3.6.9 Destructive Physical Analysis**
  - **For Space and Interceptor hardware, DPA shall be performed on 1 device per lot date code for ICs, semi-conductors, stacked capacitors, and custom magnetics**
- **MDA PMP participating in Counterfeit Part Tiger Team with NASA and Industry**

**PMP, Purchasing and Quality Organizations mus together to prevent counterfeit parts from enter**

# Obsolescence

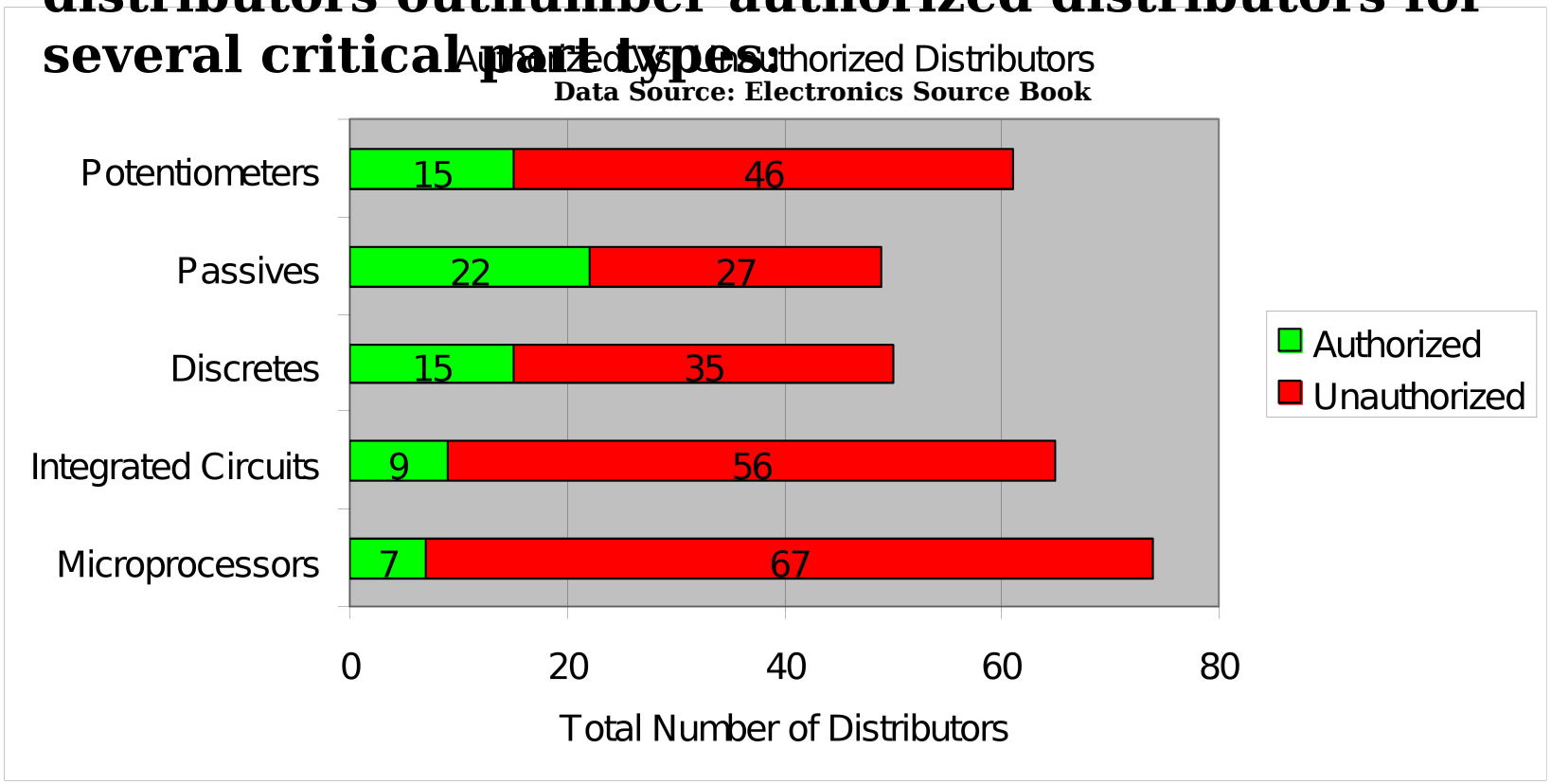
- **Developer's PMP Plan shall establish and maintain a proactive obsolescence management approach:**
- **Semi-annual health assessments required**
  - **Contractor shall report "Decline" and "Phase Out" items to PMPB**
- **Coordinate obsolescence issues with PMPB to leverage other programs**
- **A case shall be developed for all parts in "Decline" or "Phase Out" to provide optimal solution**




**Source: Semiconductor Industry Association**

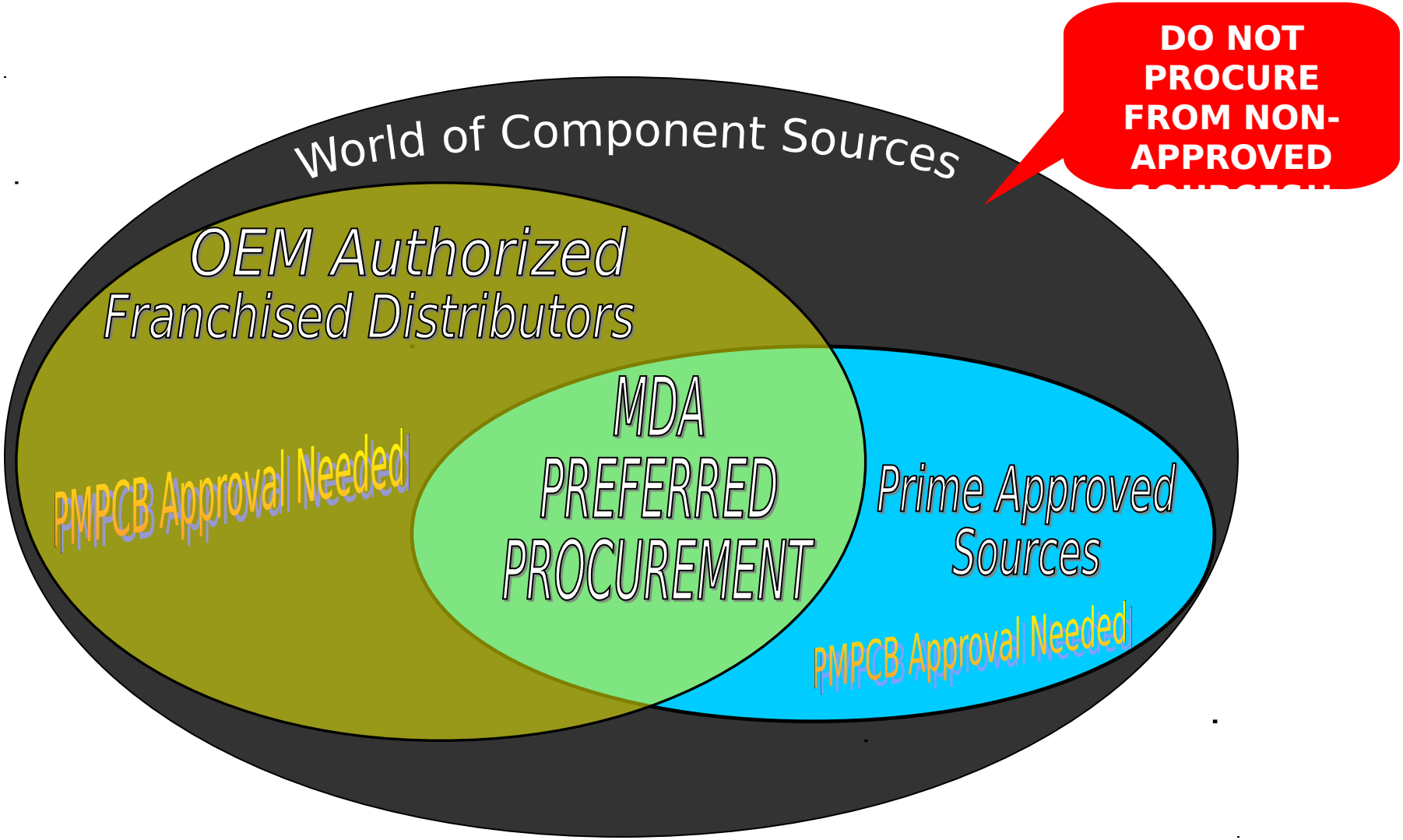
# Authorized vs. Unauthorized Distributors

**MDA PMP research found that unauthorized distributors outnumber authorized distributors for several critical part types:**




**12% of IC distributors are franchised/authoriz**

# Vendor Selection and Surveillance



# Derating

- **Appendix A covers derating requirements**
- **Derating tables cover most every EEE commodity**
  - **Types not covered shall be derated under control of the PMPCB**
  - **Proposed alternate derating also under control of PMPCB**
- **Derating extracted from SD-18 or NASA Goddard EEE-INST-002**
  - **Where SD-18 or EEE-INST-002 disagree, PMAP uses most restrictive derating value**

Capacitor Derating Table

| Type | Military Style | Voltage Derating Factor | Maximum Ambient Temperature |
|---|---|---|---|
| Ceramic | CCR, CKS, CKR, CDR **2/** | 0.60 | 110 °C |
| Glass | CYR | 0.50 | 110 °C |
| Plastic Film | CRH, CHS | 0.50 | Tmax - 35 °C |
| | | 0.30 | Tmax - 10 °C |
| Tantalum, Foil | CLR25, CLR27, CLR35, CLR3 | 0.5 | 70 °C |
| Tantalum, Wet Slug | CLR79, CLR81 | 0.60<br>0.40 | 70 °C<br>110 °C |
| Tantalum, Solid | CSR, CSS, CWR | 0.50<br>0.30 | 70 °C<br>110 °C |

**Alternate Derating Criteria can be Submitted to**

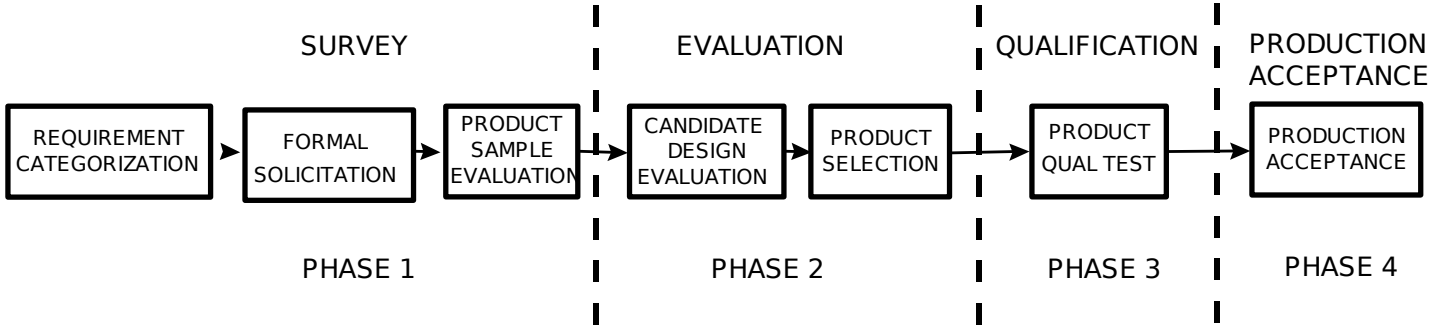
# Plastic Encapsulated Microcircuits

- **PEMS introduce certain risks to high-reliability hardware**
  - **Lower operating and junction temperatures**
  - **Unknown service life**
  - **Handling and storage restrictions**
- **Appendix B covers screening and qualification requirements for all PEMs for Categories A through D**
  - **Specific qualification flow charts and device quantities identified**
  - **PEM test flows can be tailored for silo based interceptors**
- **Category E allows use of PEMs without specific restriction**
- **Bottom Line – We need to ensure all aspects of PEM application in our hardware is proper and follows appropriate guidelines**

**MDA must ensure all aspects of PEM applicat**
**hardware is proper and follows appropriate gu**

# COTS Management

- **The product acceptance process for COTS/NDI products is organized into four phases:**




- **Acceptance of Commercial Off-the-Shelf (COTS) and Non-Developmental Items (NDI) hardware follows a structured process to assure high reliability**
- **System requirements flow-down to COTS/NDI; all items qualified for system use_**

**Contractor's Should Understand Pedigree and P of COTS Hardware; Data Sheets Should be Verif**

# PMP Requiring Special Considerations

- **Appendix E contains 11 categories of parts, materials, and processes (PM&P) that require special consideration**
- **The 11 categories include a Severity Rating from 1-3**
- **Severity ratings are based on the expected environments for Hardware Categories.**
- **3 Severity Rating categories of evaluation**
  - **Category 1: PM&P shall not be used without submission to PMPB for approval**
  - **Category 2: PM&P should be avoided if possible. Use requires documented justification, risk mitigation, and PMPCB approval**
  - **Category 3: Discouraged but not restricted. Meant as a guideline to increase reliability for the system. PMPCB approval not needed**

**Appendix E partnered with Contractor PM**

# Hardness Assurance Provisions of PMAP

- **Appendix D covers RAD HARD requirements**
- **PMAP specifies a set of radiation environments for lot sample testing, depending on the MDA Element mission.**
  - **Total dose**
  - **Dose rate (prompt effects if nuclear battle space)**
  - **Single event upset (cosmic, protons, neutrons)**
  - **Displacement damage (neutrons, protons)**
  - **Latchup (dose rate and single-event induced)**

Dose Rate Testing at
Crane Linear Accelerator

- **PMAP specifies a set of MIL-STD-883 radiation testing methods.**

**Method 1019** (total dose)

**Method 1020** (dose rate latchup)

**Method 1021** (dose rate upset for digital ICs)

**Method 1017** (neutron)

**Method 1080** (Power MOSFET burnout)

**Method 3478** (Power MOSFET dose rate)

**nce HAENS is placed on contract, Appendix D provide**
**he piece part level test requirements for each progra**

# Corrosion Prevention and Control

## *Applicability*

- **Public Law 107-314 Sec. 1067: DoD is to develop long term corrosion strategy**
- **DFARS 207.105(b)(13)(ii): Every acquisition plan will "also discuss corrosion prevention and mitigation plans"**
- **MDA is directly under the Undersecretary for Defense, AT&L - DoD Corrosion Official**
- **CPC requirements are applicable to all Acquisition Programs greater than $5M**
- **Corrosion must be addressed at appropriate program reviews**

## *Acquisition*

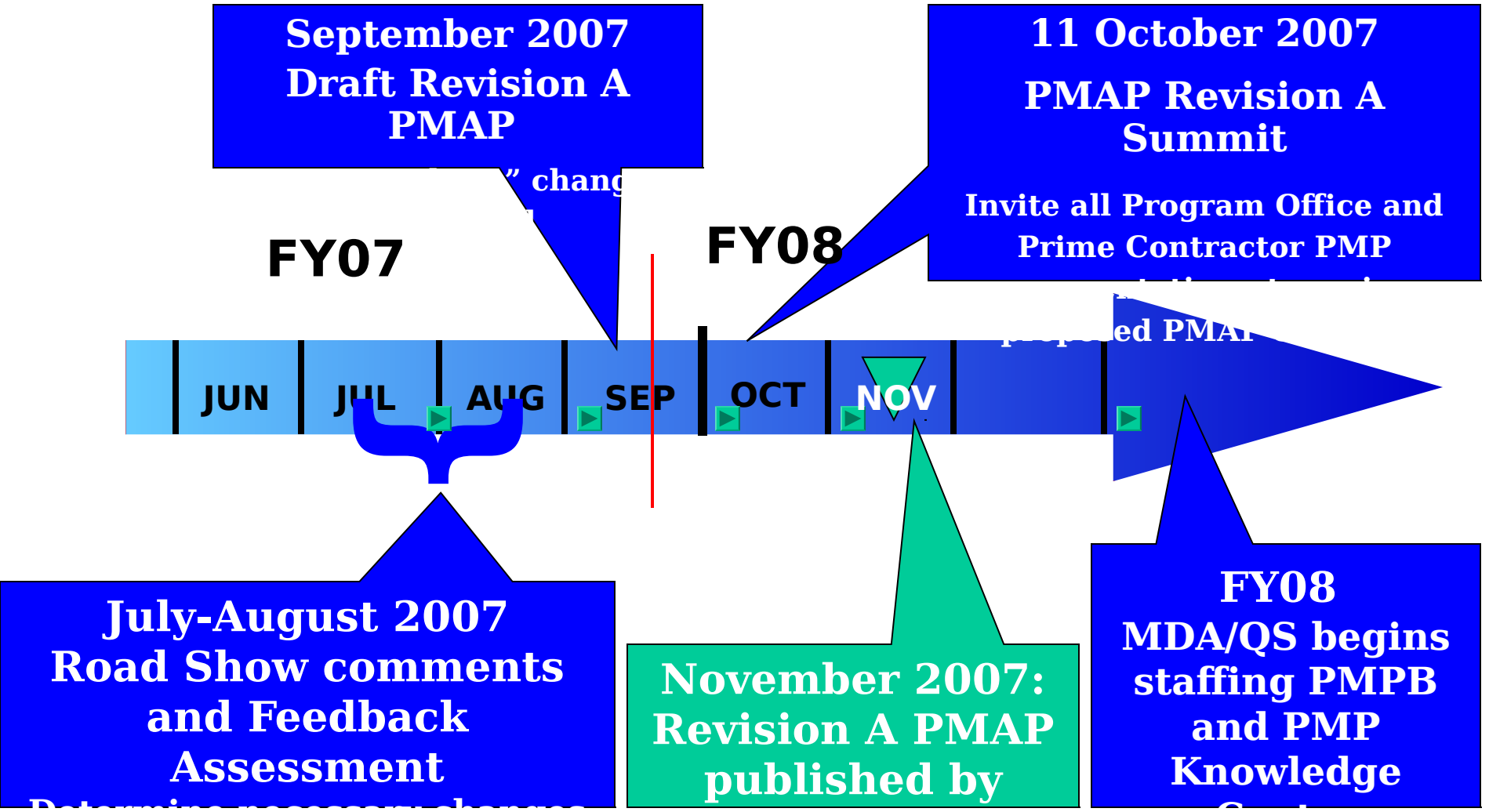
- **DOD Policy - Address Corrosion Prevention in Design**
  - **Corrosion Prevention and Control Planning Guidebook (soon a DoDI). This will be mandatory for all DoD Acquisition Programs**
  - **Corrosion Prevention and Control (CPC) Plans**
  - **Corrosion Teams (CPATs/CCBs)**

## *Sustainment*

- **Materials and Parts changes during production, fielding and post-fielding**
- **Corrosion Prevention Technologies Training/Troop Visits**
- **Problem solving for unexpected issues – especially connectors**
- **Life cycle management**

**PMAP Appendix G fulfills the DoD CPC requirement, erly implemented by the Program Office and the Cont**

# PMAP Path Forward



# Questions?